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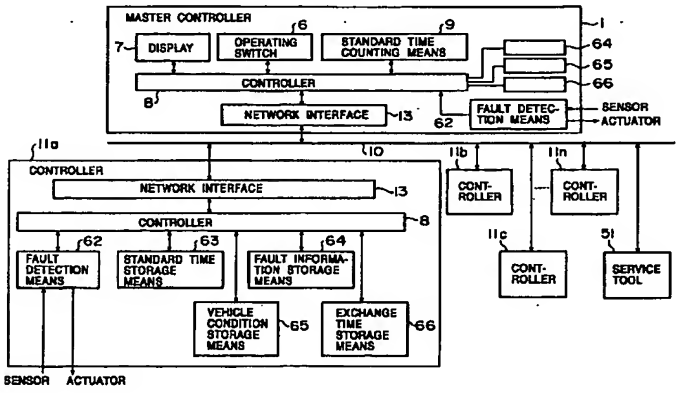
(54) SYSTEM AND METHOD FOR MANAGING TIME FOR VEHICLE FAULT DIAGNOSTIC APPARATUS

(57) Temporal contradictions and errors between controllers are eliminated and fault diagnosis is accurately performed by correct time. The system includes a master controller (1) for transmitting a measured time as a reference time, and a plurality of controllers (11a, 11b, 11c, ..., 11n) for determining the time relating to the fault diagnosis on the basis of the received reference time when fault data of sensors, etc., are detected.

FIG. 1



EP 0 838 788 A1

Description

TECHNICAL FIELD

The present invention relates to time management of a fault diagnostic apparatus for a vehicle, and more particularly, to a system and a method for managing time for a vehicle fault diagnostic apparatus for the management of a standard time between a plurality of controllers in a fault diagnostic apparatus for an industrial vehicle.

BACKGROUND ART

In the situation in which electronic control of engines and transmissions of vehicles is rapidly proceeding, functions required for controlling each component have been highly advanced. In order to satisfy the required functions, the number of devices using a microcomputer (hereinafter, referred to as CPU) in a controller for controlling each component has increased. As a result, a plurality of controllers each using the CPU are installed in an electronic control device for one vehicle. With the advancement of the functions of such an electronic control device, fault diagnosis becomes difficult, and it is an important problem how faulty points are discovered in a shorter time under fault conditions to shorten downtime of the vehicle.

In order to solve the above problem, vehicle fault diagnostic apparatuses have been proposed in which the CPU of each controller performs the fault diagnosis with respect to the respective controllers, and achieves easy diagnosis by displaying results of the diagnosis. For example, in Japanese Unexamined Patent Publication No. 4-304589, a vehicle fault diagnostic apparatus shown in Fig. 5 is proposed. According to this proposal, an electronic control device for a vehicle is composed of a master controller 1 and a plurality of controllers 11a, 11b, 11c,...11n, and the respective controllers are connected to each other by a communication network 10. The master controller 1 and the controllers are composed of a system centered on the CPU.

Each of the controllers inputs signals from a sensor and a switch to control respective components of the vehicle, and outputs a signal to control an actuator, etc. based on the signals. In addition, each of the controllers has a fault detecting section for detecting faults of the above connected sensor and actuator, and always transmits the detected fault data to the master controller 1 through the communication network 10.

The master controller 1 is composed of a CPU 2, a network interface 3, a memory 4, an operating switch 6, and a display 7. The memory 4 stores results of calculations, communication data, and fault information of the respective controllers. The CPU 2 always receives fault data from the controllers 11a, 11b, 11c,...11n using, for example, a polling method, and checks whether or not there is a bit into which "1" showing fault detection is written in fault items of the received data. When there is the bit into which "1" is written, an error code corresponding to the fault item of the bit is written into a predetermined storage area in the memory 4, and the time elapsed since occurrence of the fault is written into the predetermined storage area.

The predetermined storage area in which the error code and its elapsed time are stored, are in the form of a fault history such that the error codes are stored in the order of the time at which the error code was generated. That is, the error codes and the elapsed time are stored in the predetermined storage area in the order of generation, and when a predetermined number of error codes are stored, the next and later error codes are stored in the initial address of the above predetermined storage area. In this way, the oldest error code and its elapsed time are stored by being renewed by the latest error code and its elapsed time. In addition, each elapsed time renews the previous elapsed time per a predetermined time (one hour, for example) since occurrence of the fault. Further, when an operator investigates the cause of the fault, the operating switch 6 can be operated to display the previous fault history on the display 7. By analyzing the fault history data, the cause can be investigated in a short time.

On the other hand, with the advancement of the function of controlling the respective components as described above, an analysis of the fault diagnosis has become complicated, resulting in the increased requirement that timing of the input and output signals between the components, and the state progress of signals in the respective components be analyzed in detail. For this reason, it is necessary to store the fault history data and the state progress of the input and output signals, etc. in detail and in large quantity. Thus, in the above conventional vehicle fault diagnostic apparatus, a large memory capacity for storing the fault history data, etc. in the master controller 1 must be prepared. However, since the controllers are vehicle-mounted controllers, considering environmental resistance such as vibration resistance, dust resistance, and waterproofing, a semiconductor memory such as RAM must be used, and considering the volume, etc. to reduce the size of the controllers, the memory capacity is restricted, and cannot be sufficiently increased.

To cope with this, an arrangement can be considered in which the fault history data and the state progress of the input and output signals of the respective controllers are separately stored in respective memories of the controllers. This allows a memory of large capacity to be prepared in each controller within the restriction of each volume. In addition, an operation counting clock or a time clock is included in each of the controllers, and, with the use of these clocks, the fault data at the time of occurrence of the fault, the conditions of the input and output signals, and the fault occurrence time and the time elapsed from occurrence of the fault are stored in the respective memories in each controller.

These stored fault history data and the state progress of the input and output signals are transmitted in response to a request by the master controller 1, whereby the fault can be analyzed on the display 7, etc. on the side of the master controller 1.

In this case, however, the following problems are encountered. The operation counting clock included in each controller is operated only during the interval when the power of each controller is turned on. However, the power of each controller may be separately turned off due to the fault and an examination of each component, or a controller used in a certain period of time may be removed from the vehicle and attached to another vehicle, whereby the operation counting clocks of the power-turned-off controller and the newly attached controller cause differences between the operation counting clocks of other controllers and the master controller 1. In addition, the above operation counting clock and the time clock include clock errors between the controllers due to the variations of timers, etc. Therefore, in spite of the fault and a phenomenon occurred at the same time, there is a possibility that the stored clock values are different between controllers. This could be a major obstacle in investigation of the cause of the fault by analyzing the fault history data of the respective controllers and the state progress of the input and output signals, and the fault diagnosis might require a lot of time.

DISCLOSURE OF THE INVENTION

The present invention has been made to solve the problems of the prior art, and its object is to provide a system and a method for managing time for a vehicle fault diagnostic apparatus which can eliminate temporal contradictions and errors between controllers, and reliably perform fault diagnosis by accurate time.

According to the present invention, there is provided a system for managing time for a vehicle fault diagnostic apparatus including a plurality of controllers for detecting a fault of at least one of a sensor and an actuator and transmitting the detected fault data through a communication network, and a master controller for receiving the fault data,

wherein the master controller transmits a counted time to the plurality of controllers as a standard time, and

wherein the plurality of controllers, when detecting the fault data, determine the time relating to the fault diagnosis on the basis of the received standard time.

In addition, the master controller may comprise a standard time counting means (9) for counting the standard time, and a controller for transmitting the standard time to the plurality of controllers through the communication network.

Further, each of the plurality of controllers may comprise a standard time storage means for storing the standard time, and a controller for renewing the standard time stored in the standard time storage means on the basis of the standard time received from the master controller, and determining the time relating to the fault diagnosis on the basis of the renewed standard time when a fault occurs.

According to the above arrangements, for example, one of the plurality of controllers is used as a master controller, and the standard time (main standard time) counted by the master controller is transmitted to each of the controllers through the communication network. The respective controllers renew their own sub standard time on the basis of the received main standard time. This eliminates errors of the standard time between the controllers in the vehicle fault diagnostic apparatus, whereby the standard time can be uniformly managed in the overall apparatus.

In addition, each of the plurality of controllers may comprise a fault information storage means for storing at least one of fault occurrence time and elapsed time determined on the basis of the standard time, and the detected fault data.

According to the described arrangement, each of the controllers, when storing data of fault occurred, etc. in the fault information storage means, can store the occurrence time and the elapsed time determined on the basis of the sub standard time. Therefore, by referring to the fault data at the time of the fault diagnosis, errors and contradictions of the fault occurrence time between the controllers are eliminated, and the time can be correctly recognized, so that the fault diagnosis can be performed in a short time with no error.

In addition, each of the plurality of controllers may comprise a vehicle condition storage means for storing a signal input condition from the sensor and a signal output condition to the actuator, and occurrence time of the input and output conditions determined on the basis of the standard time.

According to the described arrangement, the controllers store the vehicle conditions together with the occurrence time determined on the basis of the sub standard time in addition to the above fault data at the time of occurrence of the fault, and at each predetermined period. By investigating the timing of the input and output signals, etc. with reference to the vehicle condition data at the time of the fault diagnosis, fault analysis is facilitated, whereby the time of diagnosis can be shortened.

In addition, each of the plurality of controllers may comprise an exchange time storage means for storing the exchange time of the controllers determined on the basis of the standard time.

According to the described arrangement, when the controller breaks down, and is exchanged for a new controller, the time for the exchange is determined on the basis of the main standard time, and stored in the exchange time storage means. This allows exchange history of each of the controllers to be referred to at the time of the fault diagnosis, thereby facilitating the diag-

nosis is. The arrangement can offer similar action and effect when used controllers are installed in a new car, or even if another used controller is installed in a used operating car.

Next, according to the present invention, there is provided a method of managing time for a vehicle fault diagnostic apparatus in which a plurality of controllers detect a fault of at least one of a sensor and an actuator connected to each of the controllers, each of the controllers stores at least one of occurrence time of the fault and elapsed time, and the detected fault data, and at least one of the time is regarded as the time relating to the fault,

wherein a master controller counts and transmits a standard time to the plurality of controllers, and each of the plurality of controllers determines the time relating to the fault on the basis of the standard time.

By the described arrangement, the controllers renew their own sub standard time on the basis of the received main standard time, so that errors of the standard time between the controllers in the vehicle fault diagnostic apparatus are eliminated, whereby the standard time can be uniformly managed in the overall apparatus.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a functional block diagram of a vehicle fault diagnostic apparatus according to an embodiment of the present invention;

Fig. 2 is a circuit diagram of the vehicle fault diagnostic apparatus according to the embodiment;

Fig. 3 is a flowchart for a time management processing of a master controller 1 according to the embodiment;

Fig. 4 is a flowchart for a time management processing of a controller 11 according to the embodiment; and

Fig. 5 is a functional block diagram of a vehicle fault diagnostic apparatus according to a prior art.

BEST MODE FOR CARRYING OUT THE INVENTION

The preferred embodiments of a system and a method for managing time for a vehicle fault diagnostic apparatus according to the present invention will now be described in detail with reference to the attached drawings.

Referring to Fig. 1, a master controller 1 and controllers 11a, 11b, 11c, ...11n control each of components of a vehicle, such as an engine, a transmission, and a brake, etc. The controllers 11a, 11b, 11c,...11n are connected to each other by means of a communication network 10, and constitute a vehicle control apparatus as a whole by transmitting and receiving control information and fault information to and from each other through the communication network 10.

Since the controllers 11a, 11b, 11c,..11n have the same construction, the description will be given taking a controller 11a as an example. Incidentally, the controllers 11a, 11b, 11c,...11n are referred to as controllers 11 in the following description for simplification. Each of the controllers 11 has a controller 8 forming a main part of processing, and the following respective processing means connected to the controller 8. A fault detection means 62 detects a fault of a sensor or an actuator by a signal input from the sensor and at signal output to the actuator, and outputs a fault detection signal to the controller 8. A standard time storage means 63 inputs and stores a standard time (hereinafter, referred to as a sub standard time) in the controllers from the controller 8. A fault information storage means 64, when a fault occurs, inputs fault data, such as an error code corresponding to the fault detection signal detected by the above fault detection means 62 and the number of times of generation of error code, and the sub standard time stored in the standard time storage means 63 from the controller 8, and stores both of them.

A vehicle condition storage means 65 inputs a transition progress of input and output signals of the above sensor and actuator from the controller 8, and stores it, for example, for each predetermined period and at the time of occurrence of the fault. An exchange time storage means 66 inputs from the controller 8 the above sub standard time at which the controller 11 are newly exchanged, and stores it. The controller 8 transmits and receives the above data to and from a master controller 1 through the communication network 10 and a network interface 13.

The master controller 1 basically has the same construction as that of each of the controllers 11, but differs from each of the controllers 11 in that it has a standard time counting means 9. The standard time counting means 9 counts a standard time of the overall vehicle fault diagnostic apparatus (hereinafter, referred to as a main standard time) in a predetermined time unit (one minute, for example). The controller 8 of the master controller 1 inputs the counted main standard time value, and the controller 8 stores the main standard time value in its own fault information storage means 64, the vehicle condition storage means 65, and the exchange time storage means 66, etc. for the fault diagnosis, similar to the controllers 11. Therefore, the master controller 1 is not limited thereto, and any one of the plurality of controllers 11 in the vehicle control apparatus may be selected as a master controller, and the standard time counting means 9 may be provided in the controller. Then, the main standard time value is transmitted to other controllers 11 through the network interface 13. The controller 8 of each of the controllers 11 receives the main standard time value, renews its own sub standard time based thereon to write into the standard time storage means 63.

In this embodiment, the master controller 1 includes an operating switch 6 and a display 7, and the operating switch 6 and the display 7 are connected to the control-

ler 8 of the master controller 1, respectively. The operating switch 6 is an input switch for designating an object to be displayed for displaying the above fault information, vehicle condition, and exchange time, etc. of the controllers 11 at the time of fault diagnosis. The display 7 displays them, and is composed of, for example, an LED display capable of displaying an error code and a generation time, and a character display capable of displaying error contents, etc. The controller 8 of the master controller 1 transmits a display object designating signal input from the operating switch 6 to another controller 11 through the communication network 10. The controller 8 of another controller 11 transmits the fault information, vehicle conditions, and exchange time, etc. corresponding to the display object designating signal to the master controller 1 through the communication network 10. The controller 8 of the master controller 1 outputs the received data to the display 7.

The operating switch 6 and the display 7 for displaying the fault information, vehicle conditions, and the exchange time, etc. may be provided on a service tool 51, which can be connected to the communication network 10. The service tool 51 may be connected exclusively for the fault diagnosis, and it may be connected to the communication network 10 either at all times or only at the time of the fault diagnosis. The service tool 51 includes the network interface 13, etc. in addition to the operating switch 6 and the display 7.

Fig. 2 is a circuit diagram in which each of the controllers 11 is composed of a microcomputer system centered on a CPU 12. A fault detection circuit 18 detects a fault of a censor or an actuator by a signal input from the sensor and a signal output to the actuator, and outputs the detected fault data to the CPU 12. A memory 14 which is a writable memory for storing data, such as fault information, vehicle condition, and exchange time, can hold its storage contents even if the power of the controllers 11 is turned off, and is composed of, for example, a RAM of a battery-protected CMOS type. The CPU 12 can transmit and receive the data to and from the other controllers 11, the master controller 1 and the service tool 51 via the communication network 10 passing through the network interface 13.

The basic construction of the master controller 1 is the same as that of each of the controllers 11. That is, it is composed of a microcomputer system centered on a CPU 2 (equivalent to the CPU 12), and comprises a fault detection circuit 18, a memory 14, and a network interface 13, etc. However, as the construction different from that of the controller 11, the master controller 1 comprises a clock circuit 5 for counting the main standard time. It is assumed that the clock circuit 5 has a circuit for sending a clock of a predetermined frequency, and counts the clock to output an interrupt service-requesting signal to the CPU 2 for each predetermined time (one minute, for example). The master controller 1 comprises an operating switch 6 and a display 7, and they are connected to the CPU 2.

The service tool 51 is composed of a similar microcomputer system centered on a CPU 52, and comprises similarly a memory 54, a network interface 13, a switch 56, and a display 57. The memory 54 stores fault diagnosis data, and may be a RAM of a battery-protected CMOS type, for example. In addition, the switch 56 and the display 57 have the same functions as those of the above operating switch 6 and the display 7 of the master controller 1, respectively. The service tool 51 can be composed of, for example, a normal personal computer, etc.

A method of managing a time for a vehicle fault diagnostic apparatus in the above arrangements will be described.

Fig. 3 shows a time management processing flow of the CPU 2 of the master controller 1 in which the following interrupt service is performed by an interrupt signal from the clock circuit 5 per a predetermined time.

(Step 100) The main standard time is read from a predetermined main standard time storage area in the memory 14, and a procedure advances to step 101.

(Step 101) The main standard time is renewed. For example, when the interrupt service is executed per one minute, one minute is added to an old main standard time to obtain a new main standard time. Then, the procedure advances to step 102.

(Step 102) The new main standard time is written in a predetermined main standard time storage area, and the procedure advances to step 103.

(Step 103) The new main standard time is transmitted to each of the controllers 11, and the procedure advances to the end of the interrupt service.

By the interrupt service as described above, the CPU 2 can renew the main standard time for each predetermined time, and transmit the renewed main standard time to each of the controllers 11 through the communication network 10.

Next, the time management processing of the CPU 12 of each of the controllers 11 will be described with reference to a flowchart of Fig. 4. Here, it is assumed that the CPU 12 performs the following processing per a predetermined period. However, the processing period of the CPU 12 is set to a short period such that an error with respect to the predetermined period of the CPU 2 for transmitting the main standard time (that is, a renewal unit time of the sub standard time) can be ignored. In addition, in the following processing, the exchange time represents a standard time when the respective controllers 11 are mounted to the present vehicle and the power is initially turned on. The sub standard time is the standard time stored in each of the controllers 11, and the sub operating time represents the operating time in which each of the controller 11 is used. In addition, when each of the controllers 11 is a new article and the power is initially turned on, the data of the exchange time, sub standard time, and sub operating time are initialized to 0.

(Step 111) The sub standard time, the sub operat-

ing time and the exchange time are read from predetermined storage areas of the memory 14, and the procedure advances to step 112.

(Step 112) The main standard time is received from the master controller 1, and the procedure advances to step 113.

(Step 113) The sub standard time is compared with the main standard time to check whether or not they are equal to each other. When they are equal to each other, the procedure advances to end (completion of the processing) as the main standard time has not been renewed yet. When they are not equal to each other, the procedure advances to step 114 as the main standard time has been renewed.

(Step 114) It is judged whether or not the difference between the sub standard time and the main standard time is 1 (renewal unit time). When the different is 1, it is a normal time renewal, and the procedure advances to step 115. If not, the procedure advances to step 118.

(Step 115) It is judged whether or not the main standard time is 1 (renewal unit time). When the main standard time is 1, the vehicle is a new car, and the procedure advances to step 116. When the main standard time is not 1, it is a normal time renewal, and the procedure advances to step 117.

(Step 116) Since the vehicle is the new car, one renewal unit time is subtracted from the main standard time to set the exchange time to 0. Then, the procedure advances to step 117.

(Step 117) Since one renewal unit time has elapsed from the preceding processing, the sub operating time is incremented by one renewal unit time, and the procedure advances to step 121.

(Step 118) It is judged whether or not the main standard time is 1 (renewal unit time). When the main standard time is 1, the vehicle is a new car, and from the result of step 114, used controllers in which the sub standard time advances are installed, and the procedure advances to step 119. When the main standard time is not 1, the vehicle is a used operating car, and the procedure advances to step 120.

(Step 119) Since the vehicle is the new car, one renewal unit time is subtracted from the main standard time to set the exchange time to 0. Then, the procedure advances to step 121.

(Step 120) Since the vehicle is the used operating car, the exchange time is equalized to the main standard time, and the procedure advances to step 121.

(Step 121) Since one renewal unit time has elapsed from the preceding processing, the sub standard time is equalized to the main standard time, and the procedure advances to step 122.

(Step 122) The renewed sub standard time, sub operating time, and exchange time are written in each of the predetermined storage areas of the memory 14 to complete the processing.

In this way, when the main standard time is renewed by one renewal unit time, the CPU renews the sub standard time, the sub operating time, and the exchange time stored in each of the controllers 11 based on a new main standard time. Therefore, since these times are uniformly renewed by the main standard time of the master controller 1, time errors between the controllers 11 are eliminated.

In addition, each of the controllers 11 stores time data based on the uniform standard time when storing fault information, vehicle conditions, etc. at the time of occurrence of the fault in the predetermined areas. That is, the CPU 12, when inputting fault data detected by the fault detection circuit 18, reads out the sub standard time at the time of occurrence of the fault (hereinafter, referred to as a fault occurrence time) and the sub operating time, and writes the fault data, the fault occurrence time, and the sub operating time as fault information in predetermined fault information storage areas of the memory 14. Further, an elapsed time from the time of occurrence of the fault can be stored as fault information, and the elapsed time can be determined by subtracting the fault occurrence time from the sub standard time for each predetermined time. The CPU 12 writes the input sensor signal, the output actuator control signal, and the input and output times thereof into the predetermined vehicle condition storage area, for example, for each predetermined period.

In addition, these fault information, the vehicle conditions, and the exchange time, etc. can be displayed on the display 7 by the operating switch 6 of the master controller 1. Further, in the case of connecting the service tool 51, they can be displayed in the same manner as described above. By viewing these display contents, the details of the fault, the fault occurrence time, and the elapsed time, the input and output signals, and the input and output times thereof, and the exchange time can be analyzed in proper sequence of time, so that inquiries into the cause of the fault can be certainly conducted.

INDUSTRIAL APPLICABILITY

The present is useful as a system and a method for managing time for a vehicle fault diagnostic apparatus which can uniformly manage time, and reliably perform the fault diagnosis by accurate time because the time of a plurality of controllers are renewed on the basis of a standard time of a master controller.

Claims

1. A system for managing time for a vehicle fault diagnostic apparatus including a plurality of controllers (11a, 11b, 11c,..., 11n) for detecting a fault of at least one of a sensor and an actuator and transmitting the detected fault data through a communication network (10), and a master controller (1) for receiving said fault data,

   wherein said master controller (1) transmits a counted time to said plurality of controllers (11a,

11b, 11c,..., 11n) as a standard time, and

wherein said plurality of controllers (11a, 11b, 11c,..., 11n), when detecting said fault data, determine the time relating to the fault diagnosis on the basis of said received standard time.

2. A system for managing time for a vehicle fault diagnostic apparatus according to claim 1, wherein said master controller (1) comprises:

a standard time counting means (9) for counting said standard time; and
a controller (8) for transmitting said standard time to said plurality of controllers (11a, 11b, 11c,..., 11n) through said communication network (10).

3. A system for managing time for a vehicle fault diagnostic apparatus according to claim 1, wherein each of said plurality of controllers (11a, 11b, 11c,..., 11n) comprises:

a standard time storage means (63) for storing said standard time; and
a controller (8) for renewing the standard time stored in said standard time storage means (63) on the basis of the standard time received from said master controller (1), and determining the time relating to the fault diagnosis on the basis of said renewed standard time when a fault occurs.

4. A system for managing time for a vehicle fault diagnostic apparatus according to any one of claims 1 to 3, wherein each of said plurality of controllers (11a, 11b, 11c,..., 11n) comprises a fault information storage means (64) for storing at least one of fault occurrence time and elapsed time determined on the basis of said standard time, and said detected fault data.

5. A system for managing time for a vehicle fault diagnostic apparatus according to any one of claims 1 to 3, wherein each of said plurality of controllers (11a, 11b, 11c,..., 11n) comprises a vehicle condition storage means (65) for storing a signal input condition from said sensor and a signal output condition to said actuator, and occurrence time of said input and output conditions determined on the basis of said standard time.

6. A system for managing time for a vehicle fault diagnostic apparatus according to any one of claims 1 to 3, wherein each of said plurality of controllers (11a, 11b, 11c,..., 11n) comprises an exchange time storage means (66) for storing the exchange time of said controllers (11a, 11b, 11c,..., 11n) determined on the basis of said standard time.

7. A method of managing time for a vehicle fault diagnostic apparatus in which a plurality of controllers (11a, 11b, 11c,..., 11n) detect a fault of at least one of a sensor and an actuator connected to each of said controllers, each of said controllers stores at least one of occurrence time of said fault and elapsed time, and the detected fault data, and at least one of said time is regarded as the time relating to said fault,

wherein a master controller (1) counts and transmits a standard time to said plurality of controllers (11a, 11b, 11c,..., 11n), and each of said plurality of controllers (11a, 11b, 11c,..., 11n) determines the time relating to said fault on the basis of said standard time.

FIG. 1

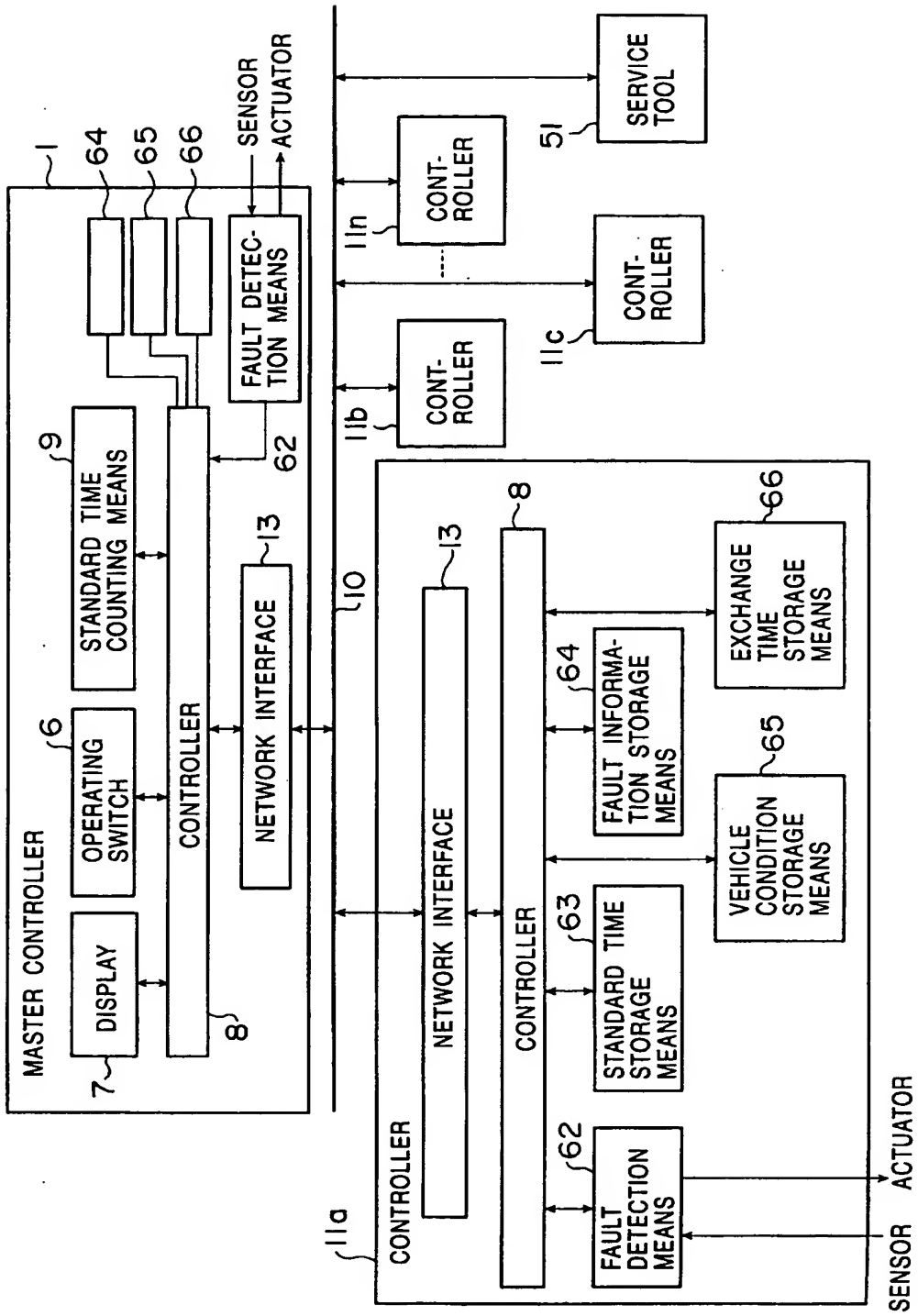

MASTER CONTROLLER
1
DISPLAY
7
OPERATING SWITCH
6
CONTROLLER
8
STANDARD TIME COUNTING MEANS
9
NETWORK INTERFACE
13
FAULT DETECTION MEANS
62
64
65
66
SENSOR
ACTUATOR
10
11a
11b
11c
11n
CONTROLLER
CONT-ROLLER
CONT-ROLLER
CONT-ROLLER
SERVICE TOOL
51
NETWORK INTERFACE
13
CONTROLLER
8
FAULT DETECTION MEANS
62
STANDARD TIME STORAGE MEANS
63
FAULT INFORMATION STORAGE MEANS
64
VEHICLE CONDITION STORAGE MEANS
65
EXCHANGE TIME STORAGE MEANS
66
SENSOR
ACTUATOR

FIG. 2

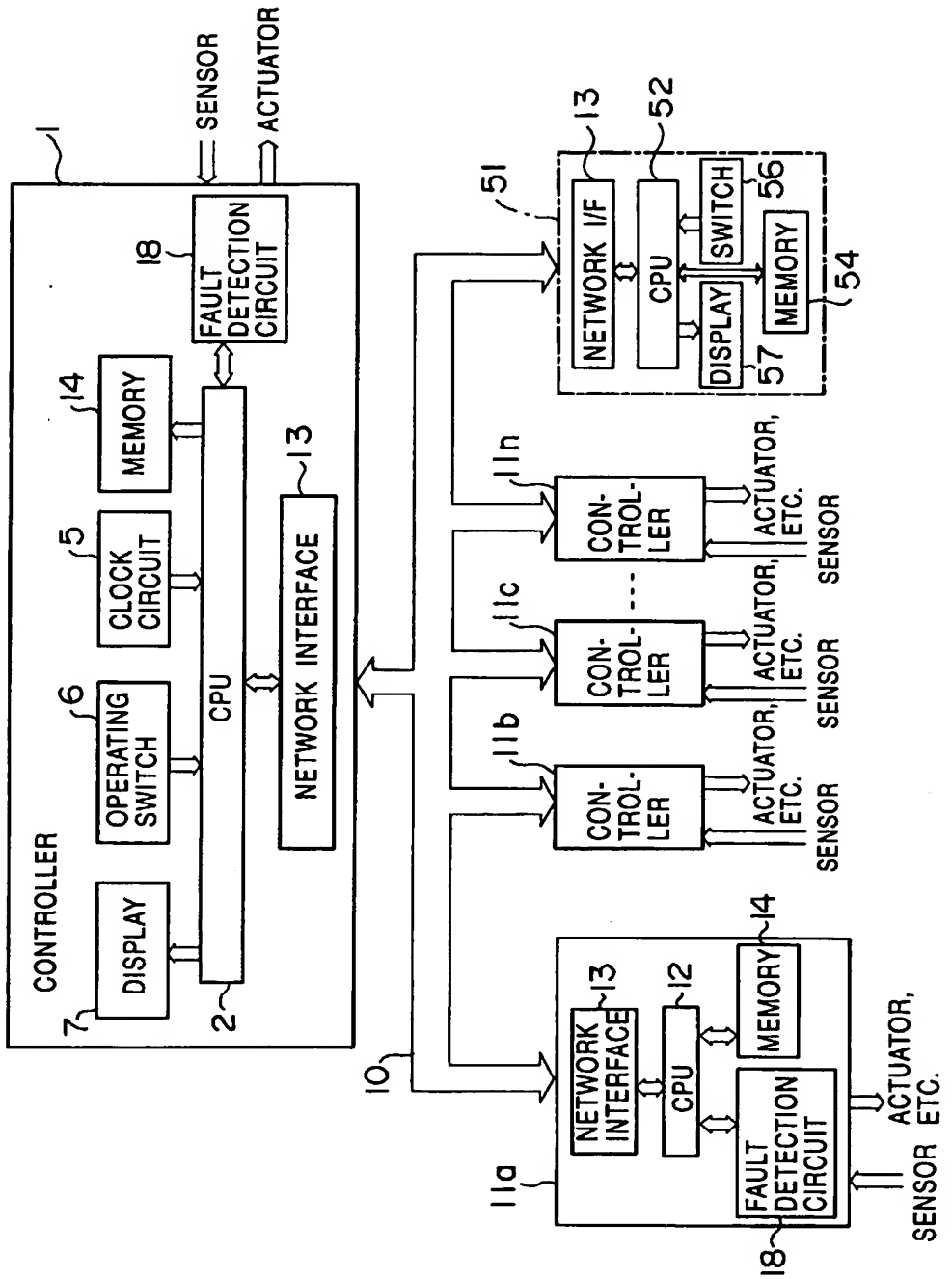

CONTROLLER
DISPLAY
OPERATING SWITCH
CLOCK CIRCUIT
MEMORY
FAULT DETECTION CIRCUIT
CPU
NETWORK INTERFACE
SENSOR
ACTUATOR
NETWORK I/F
SWITCH
MEMORY
CON-TROL-LER
ACTUATOR, ETC.
SENSOR
NETWORK INTERFACE
CPU
MEMORY
FAULT DETECTION CIRCUIT
ACTUATOR, SENSOR ETC.

FIG. 3

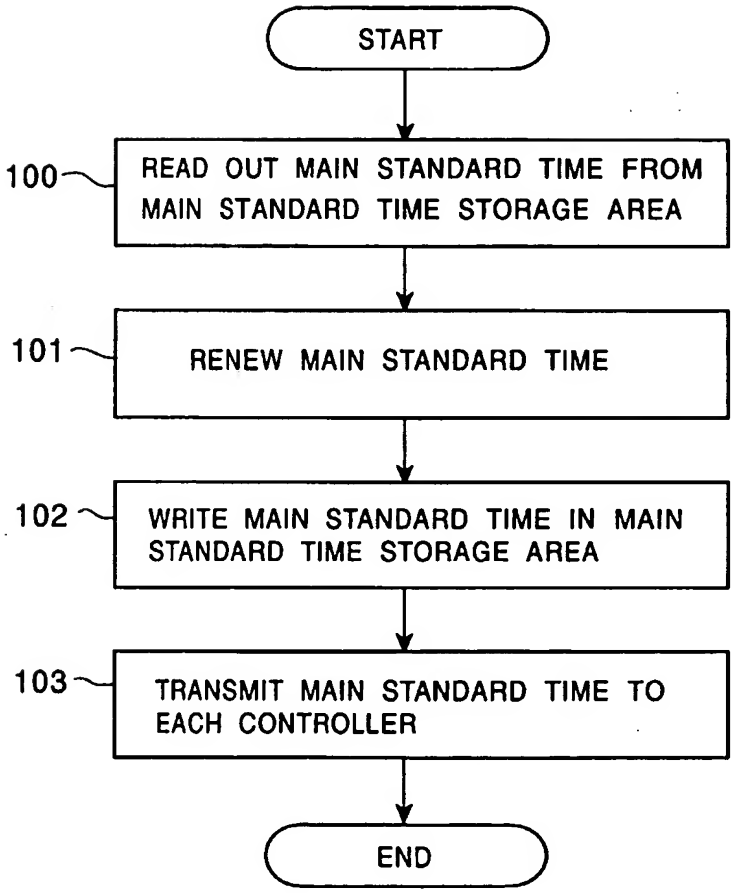

START
100
READ OUT MAIN STANDARD TIME FROM MAIN STANDARD TIME STORAGE AREA
101
RENEW MAIN STANDARD TIME
102
WRITE MAIN STANDARD TIME IN MAIN STANDARD TIME STORAGE AREA
103
TRANSMIT MAIN STANDARD TIME TO EACH CONTROLLER
END

FIG. 4

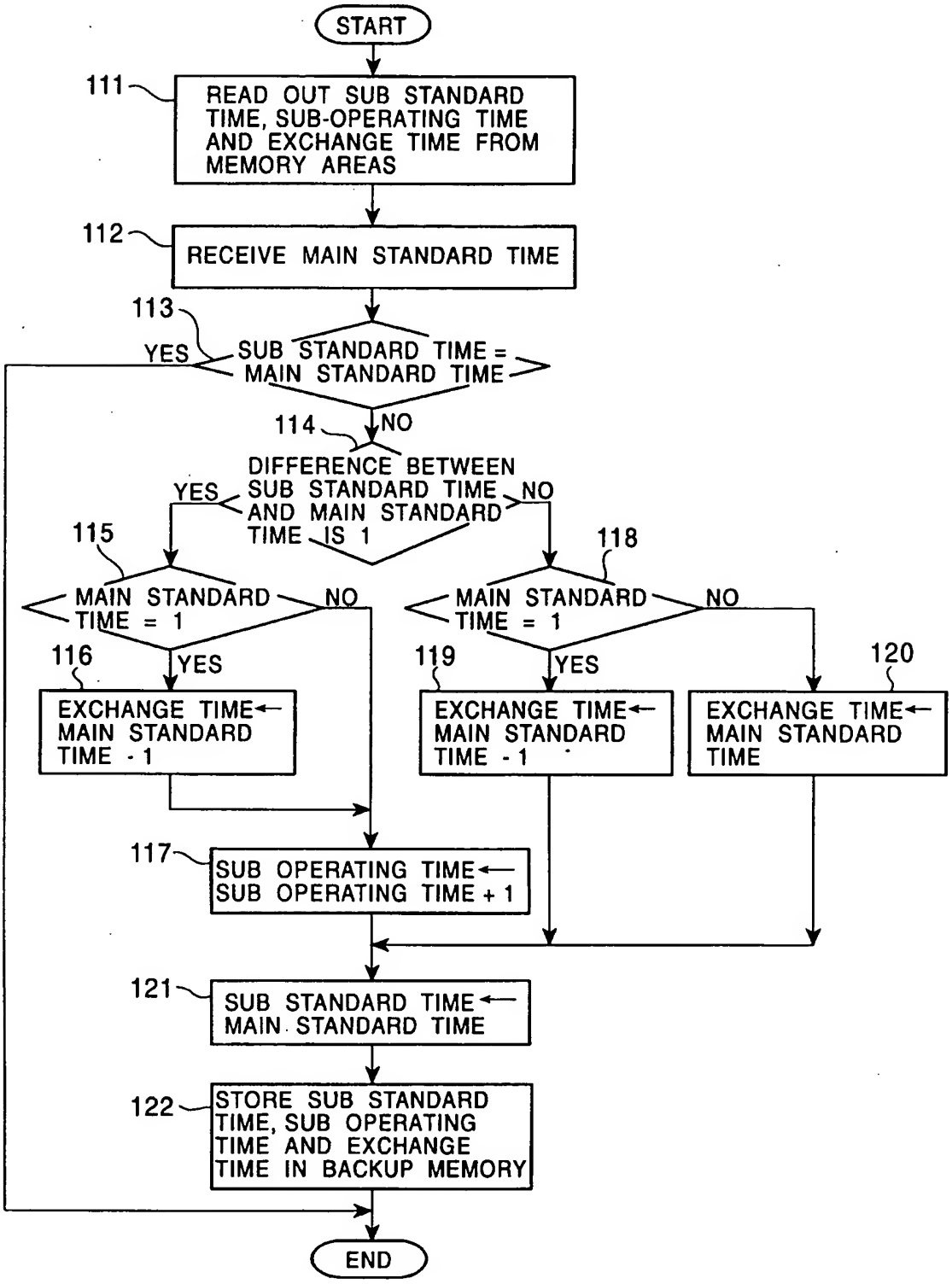
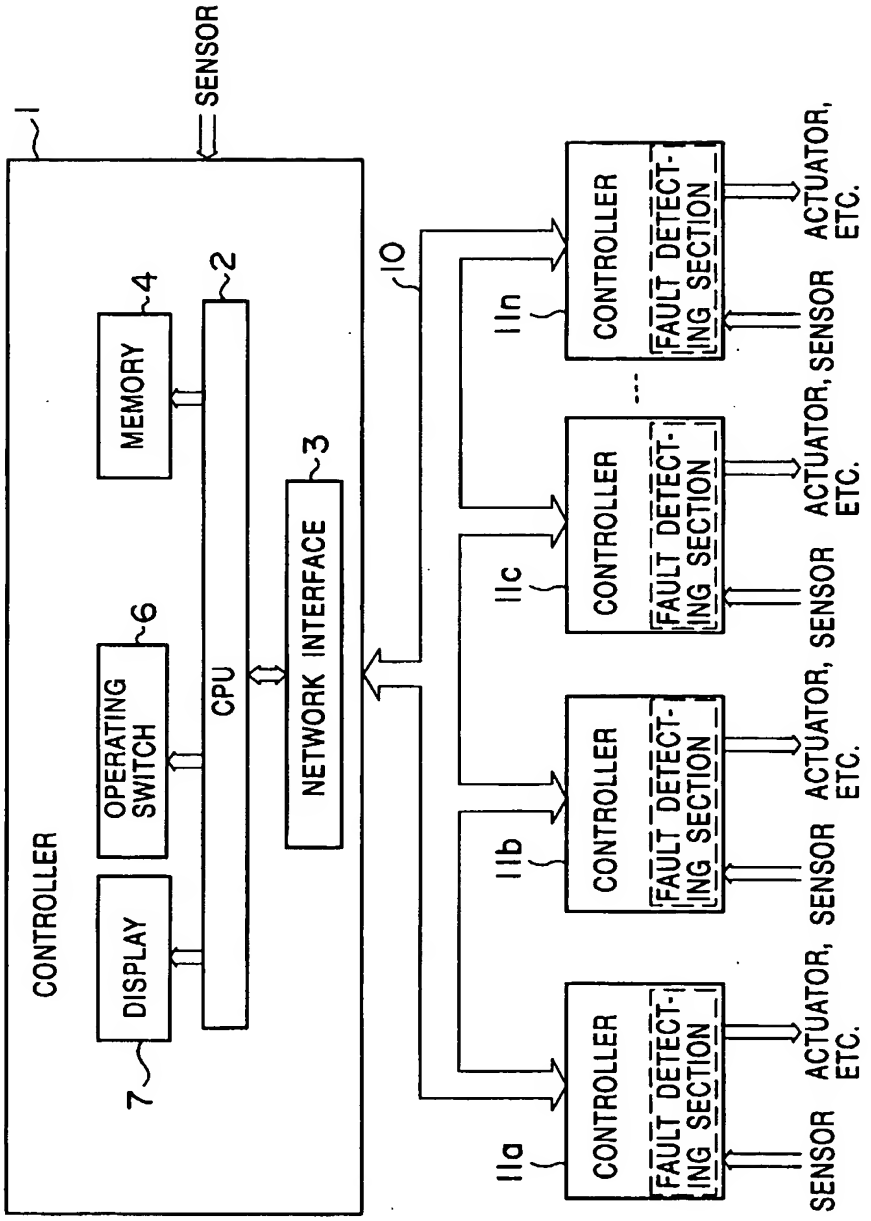

START
111
READ OUT SUB STANDARD TIME, SUB-OPERATING TIME AND EXCHANGE TIME FROM MEMORY AREAS
112
RECEIVE MAIN STANDARD TIME
113
SUB STANDARD TIME = MAIN STANDARD TIME
YES
NO
114
DIFFERENCE BETWEEN SUB STANDARD TIME AND MAIN STANDARD TIME IS 1
YES
NO
115
MAIN STANDARD TIME = 1
NO
YES
116
EXCHANGE TIME ← MAIN STANDARD TIME - 1
118
MAIN STANDARD TIME = 1
NO
YES
119
EXCHANGE TIME ← MAIN STANDARD TIME - 1
120
EXCHANGE TIME ← MAIN STANDARD TIME
117
SUB OPERATING TIME ← SUB OPERATING TIME + 1
121
SUB STANDARD TIME ← MAIN STANDARD TIME
122
STORE SUB STANDARD TIME, SUB OPERATING TIME AND EXCHANGE TIME IN BACKUP MEMORY
END

FIG. 5


1
SENSOR
CONTROLLER
DISPLAY
7
OPERATING SWITCH
6
CPU
2
MEMORY
4
NETWORK INTERFACE
3
10
11a
CONTROLLER
FAULT DETECTING SECTION
SENSOR
ACTUATOR, ETC.
11b
CONTROLLER
FAULT DETECTING SECTION
SENSOR
ACTUATOR, ETC.
11c
CONTROLLER
FAULT DETECTING SECTION
SENSOR
ACTUATOR, ETC.
11n
CONTROLLER
FAULT DETECTING SECTION
SENSOR
ACTUATOR, ETC.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP96/01366

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl^6 G07C3/00, B60R16/02, G08B21/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl^6 G07C1/00-15/00, B60R16/00-17/02, G08B19/00-21/00, G06F17/00-19/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926 - 1996
Kokai Jitsuyo Shinan Koho 1971 - 1996

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 04-304589, A (Komatsu Ltd.), October 27, 1992 (27. 10. 92)(Family: none)	1 - 7
A	JP, 06-333117, A (Yazaki Corp.), December 2, 1994 (02. 12. 94)(Family: none)	1 - 7
A	JP, 56-057541, A (Niles Parts Co., Ltd.), May 20, 1981 (20. 05. 81)(Family: none)	1 - 7
A	JP, 60-011093, U (Toshiba Corp.), January 25, 1985 (25. 01. 85)(Family: none)	1 - 7

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
June 12, 1996 (12. 06. 96)	June 25, 1996 (25. 06. 96)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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